



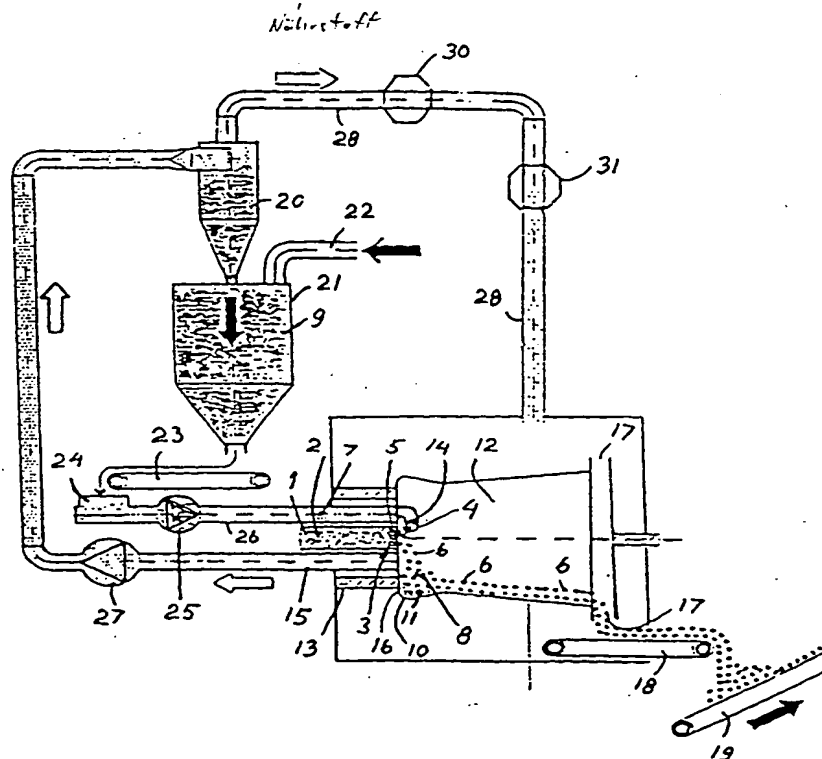
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁵ : <u>C05F 7/00, B01J 2/20</u>	A1	(11) International Publication Number: WO 94/14730 (43) International Publication Date: 7 July 1994 (07.07.94)
(21) International Application Number: PCT/SE93/01112 (22) International Filing Date: 29 December 1993 (29.12.93) (30) Priority Data: 9203930-4 29 December 1992 (29.12.92) SE (71)(72) Applicant and Inventor: MODIG, Torsten [SE/SE]; Bro- gatan 2, S-903 25 Umeå (SE). (74) Agents: BJELKSTAM, Peter et al.; Kransell & Wennborg AB, P.O. Box 27834, S-115 93 Stockholm (SE).		(81) Designated States: US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published With international search report. With amended claims. In English translation (filed in Swedish).

(54) Title: A METHOD AND AN APPARATUS FOR PRODUCING PLANT NUTRITIVE PELLETS FROM WASTEWATER SLUDGE

(57) Abstract

The invention relates to a method and an apparatus for producing plant nutritive pellets from wastewater treatment plants, so-called raw sludge, with a water content normally in the region of 70-80 %, where a powder (9) is used to stabilize the pellets (6) and prevent their sticking together. The powder (9) is added in connection with the sludge being formed into at least one pellet string or immediately after formation when the string has been cut into pellets (6), an air stream (7), in which the powder (9) has become entrained being used to douse the pellet string or the cut-off pellets, whereafter drying is readily performed to provide a predetermined moisture content of about 10-15 % (90-85 %, DS) adequate for storage. The device according to the invention comprises an extruder (1) to form at least one pellet string (5), which by cutting-off means (29) is cut into separate pellets (6), at least one blowing nozzle (14) for lime powder (9) intended to be doused over the pellets, a rotatable tumbler (12) and a drying kiln, in which the pellets (6) are dried to said moisture content adequate for storage.



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A method and an apparatus for producing plant
nutritive pellets from wastewater sludge

The present invention relates to a method and an apparatus for producing plant nutritive pellets from the sludge arising from wastewater treatment.

The major part of all sludge from wastewater treatment plants is deposited on garbage dumps in spite of the sludge containing valuable plant nutrition. The reason for this is not primarily fear of heavy metals in the sludge but, above all, the difficulties farmers have in dealing with such sludge continuously. Previously, attempts have been made to form the sludge into pellets directly but this has been found impossible, since the mass has too loose a structure, because of its high (70-80%) water content. Getting below this water content percentage has been found to be impossible in the sludge handling process, since most of the water in the sludge is cell-bound. In addition, it is very sticky, resulting in that any pellets formed quickly stick together and form large aggregates. It is almost impossible to dry out these large lumps to a sufficiently low water content for storage. These masses are also an infection hazard, since they always contain infectious substances, e.g. salmonella bacteria, different viruses and parasite eggs.

The object of the present invention is to provide a method and an apparatus of the kind mentioned above, where the pellets can be formed directly, while preventing the formation of aggregates, such that there is the possibility of effectively drying the pellets down to a water content of about 12-15%, which is adequate for storage, and simultaneously eliminating the infec-

tion hazard during handling. The distinguishing features of the invention have been disclosed in the following claims.

5 By reason of the invention there has now been provided a method and an apparatus that fulfil the inventive objects in an excellent manner. The following advantages are obtained by the pelletization. By dousing the pellets with a preferably hygroscopic powder they will
10 be stiffer as they are pressed out from the extruder, thus enabling them to maintain their shape. The coating of dry powder also prevents them from sticking together to form aggregates as well as enabling them to be dried more easily and quickly. The dry powder, which can be
15 hygroscopic, rapidly absorbs moisture from the surfaces of the newly formed pellets and this moisture is then rapidly drawn away in the hot, dry atmosphere of the tumbler. As the powder is dried out it loosens from the pellets, enabling it to be recycled in the process. The
20 pellets may then be dried conventionally, e.g. as with cereals, to a water content of about 12-15%, adequate for storage. Pellets produced according to the invention can in this way now be delivered at a time suitable to agriculture, since they are capable of being
25 stored. In addition, they can be spread in the same way as artificial fertilizers and thus take the place of large amounts of the latter. The risk of spreading infection is inhibited by heating the pellets to a temperature of 80°C for fifteen seconds. By using
30 modern heat exchanger technology, drying and pelletization according to the invention can take place with very low energy requirements.

The invention will now be described in more detail with the aid of a preferred embodiment and with reference to the accompanying drawing, where

5 Fig. 1 schematically illustrates an apparatus for carrying out the method in accordance with the invention, and

10 Fig. 2 schematically illustrates, to an enlarged scale, a section through the extruder nozzle and openings therein, which are provided with an annular, peripherally slotted jet for blowing out compressed air.

15 Fig. 1 is a schematic view of an apparatus for producing plant nutritive pellets from the sludge arising from wastewater treatment. Pelletization takes place with the aid of an extruder 1, through which the sludge 2 is urged to at least one nozzle 3, which has at least one orifice 4. In the illustrated example, the nozzle 3
20 has a plurality of orifices 4 located close to each other, through which the sludge can be urged to form a plurality of mutually parallel pellet strings 5. Cutting-off means, not illustrated in detail on the drawing, are provided for cutting off the separate pellets
25 6 from the pellet strings 5. The cutting-off means may comprise a compressed air stream coming from an annular, peripherally slotted jet 29, schematically illustrated in cross-section in Fig. 2. The jet means is
30 disposed such as to direct the air stream convergingly to the centre of the nozzle 3. A thin wire can also be used for cutting off the pellets or any other suitable means may be used. However, the air stream jet functions in a way eliminating the risk of forming deposits from the sticky mass, which can otherwise occur, particularly on knives, if such are used. In the vicinity of
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the orifices 4 there is at least one nozzle 14 for blowing powder 9 on to the pellets. This nozzle 14 is directed towards the nozzle 3 in a suitable way for blowing powder 9 entrained in an air stream 7 such as to completely coat the extruded pellet strings 5 and/or the separated pellets 6. In the preferred embodiment example according to the invention the latter also prescribes that dousing with powder can take place continuously or intermittently. For other inventive embodiments, dousing can naturally take place either before the pellet strings 5 have been cut up, as they are cut or after separation into separate pellets 6. The inventive apparatus includes a rotatable tumbler 12, situated below the extruder 1, and the tumbler is provided with a depression 10 inside it for collecting an amount 11 of excess powder, in which a quantity 8 of pellets 6 can be collected. The depression 10 is in the closed portion 16 of the tumbler 12, this portion being mounted for rotation in a fixed member 13 of the apparatus. The fixed member 13 houses the extruder 1, the powder nozzle 14, the air stream 7 for entraining the powder 9, a suction duct 15 for excess powder and finally the annular, slotted jet 29. The end of the tumbler 12 remote from the depression 10 coacts with a gap 17, through which the coated pellets 6 pass, and below them is a conveyor 18 for transferring the pellets 6 to a conveyor 19, which takes them to a conventionally operating drying kiln. Predrying of the pellets thus takes place in the tumbler 12 until the powder coating loosens and they have obtained a certain amount of strength, whereafter final drying is performed in the kiln in a manner known per se.

As will be seen from Fig. 1, the inventive pelletization apparatus may also include a hopper 21 for the

lime powder 9 and it can be filled via a duct 22. The lime powder 9 is discharged onto a conveyor 23, from whence it is fed into a duct 26 via an opening 24. Different means for powder dousing can be envisaged, e.g. such as use of compressed air. With such a means a special vacuum nozzle is used to suck up the powder directly from the hopper 21 for subsequently spraying it over the extruder nozzle 3. In Fig. 1 there is illustrated a blower 25 in the duct 26 for blending air and lime powder 9 such as to entrain the latter in an air stream 7 passing through the duct 26 to the nozzle 14. The powder 9, whirling around in the tumbler or forming a mass 11 in the depression 10, is recycleable and sucked out via the duct 15 with the aid of a blower 27 and further up to a cyclone 20 having an unillustrated filter. Powder 9 is discharged from the cyclone 20 into the hopper 21. Return air from the cyclone is taken via a duct 28 past a cooling battery 30 for cooling and dewatering and past a heating battery 31 for subsequent entry into the tumbler 12, thus ensuring that air entering the tumbler has a very low moisture content. It is intended that this air causes strong turbulence in the tumbler, so that excess powder on the pellets loosens, enabling such powder to be recycled.

With the aid of the apparatus described above the method according to the invention is adopted as follows: The sludge coming from a wastewater treatment plant is fed in a manner not illustrated here to and through the extruder 1, such as to be urged through the extruder nozzle 3 the latter having a plurality of orifices 4, through which the sludge 2 passes to form separate, mutually parallel pellet strings 5. As they come out from the orifices 4 the strings 5 are cut off to form individual pellets 6 with the aid of the air

stream coming from the annular, peripherally slotted jet 29, simultaneously as the pellet strings projecting from the orifices and/or the cut-off pellets are continuously doused with powder entrained in an air stream.

5 The purpose of dousing the pellets is to facilitate drying them, stiffen the pellet strings and prevent the pellets from forming aggregations as they come from the orifices 4. Simultaneously as this takes place the tumbler 12 is rotating and the pellets 6, that have
10 fallen down into it, are effectively given a complementary coating of powder 9 over their entire surface from the powder in the depression 10 as well as powder in the bottom part of the tumbler. The pellets 6 move along the inner shell surface of the tumbler 12 from
15 the depression 10 and, at the end of the tumbler 12 remote from the depression, they fall via a slot 17 onto a conveyor 18 to be transferred to a conveyor 19 taking them to the drying kiln, unillustrated on the drawing. Using known technique they are dried there for
20 a predetermined time to a water content of about 12-15%, adequate for storage. In a preferred application of the method, the pellets are heated in one of the sequences in the drying process, e.g. using a microwave oven, to a temperature of about 80°C for 15
25 seconds. The dosage of a suitable quantity of powder in relation to extruder capacity and recycling excess powder are regulated as desired. The drying process is facilitated and the water content in the pellets is lowered with the aid of powdering, using the dry lime
30 powder.

The addition of a lime powder will not notably make the sludge handling more expensive, since wastewater handling plants normally add lime (about 200-300 kg per
35 tonne sludge dry substance). The originally lime-lack-

ing sludge has lime added to make it more attractive to agriculture from the plant nutrition aspect. However, this addition could be questioned, since alkalization causes nitrogen losses due to the departure of ammonium hydrate. Coating the surfaces of the pellets with lime powder does not give such large nitrogen losses as does mixing lime into the whole mass. With the powder coating only the actual surfaces will be alkalized and during storage of dried pellets there are no nitrogen losses, since the chemical processes practically cease with low water content. It may therefore be assumed that pelletized sludge will have a higher nitrogen content than untreated sludge.

Claims

1. A method of producing plant nutritive pellets from wastewater treatment plants, so-called raw sludge, with
5 a water content normally in the region of 70-80%
(30-20%, dry substance, DS), where pelletization takes place without further dewatering of the sludge (2) and where a powder (9) is used to stabilize the pellets (6) and prevent their sticking together, characterized in
10 that the powder (9) is added in connection with the sludge (2) being formed into at least one pellet string, or immediately after formation when the string is cut into pellets (6), an air stream (7), in which the powder (9) has become entrained being used to douse
15 the pellet string or the cut-off pellets such as to give the soft pellet string or the cut-off pellets (6) improved strength, and to prevent the formation of pellet aggregates during subsequent collection of the string or cut-off pellets (6), whereafter drying is
20 readily performed to provide a predetermined moisture content of about 10-15% (90-85%, DS) adequate for storage.

2. A method as claimed in claim 1, where pelletization
25 takes place preferably with the aid of an extruder (1), through which the sludge (2) is urged towards at least one extruder nozzle (3) having at least one extruding orifice (4), and preferably a plurality of such orifices arranged adjacent each other, through which the
30 sludge can be urged such as to form a plurality of separate, mutually parallel pellet strings (5), characterized in that after exiting from the orifices (4) said strings (5) are cut into separate pellets (6) simultaneously as the actual strings and/or the pellets

(6) are continuously doused with the air stream (7) and its entrained powder.

3. A method as claimed in claim 1 or 2, characterized in that the powder entrained in the air stream (7), which is directed towards the orifices (4), is a lime powder (9), which first coats the pellet strings protruding from the orifices as well as the cut-off pellets (6) when they are in an air space in front of the nozzle (3) and when they fall down into a depression (10) below the nozzle (3), said depression (10) having room for a powder mass (11).

4. A method as claimed in any one of the preceding claims, characterized in that the pellets (6) coated with excess lime are rotated in excess lime powder, which collects at the bottom of the rotating tumbler (12), said pellets being discharged from the tumbler via a slot (17), while excess powder from the pellets is recovered.

5. A method as claimed in any one of the preceding claims, characterized in that the flow of powder-coated pellets (6) coming from the tumbler (12) via the slot (17) is conveyed to a drying kiln (19), in which the pellets (6) are dried for a given time, such as to obtain a moisture content of about 10-15% (90-85%, DS), subsequent to which the pellets (6) are bagged and stored.

6. A method as claimed in claim 5, characterized in that the sludge or pellets are heated during the process to about 80°C for about 15 seconds in order to kill pathogenic bacteria, parasite eggs etc.

7. An apparatus for producing plant nutritive pellets from the sludge arising from wastewater treatment plants, and which includes an extruder (1) with a nozzle (3) provided with at least one orifice (4) for forming the sludge (2) into at least one pellet string (5), there also being means (29) for cutting pellets (6) from the string (5), characterized in that there is at least one blowing nozzle (14) for lime powder (9) in coaction with the orifice (4), in that via a fixed member (13) the extruder (1) is surrounded by, and opens out into, a rotatable tumbler (12) having excess powder at its lowest region, and in that via a slot (17) the tumbler (12) opens out above at least one conveyor (18, 19) for conveying the powdered pellets (6) further to a drying kiln, in which the pellets (6) are dried to a predetermined moisture content during a given time, subsequent to which the pellets are ready for bagging and storage.
8. An apparatus as claimed in claim 7, characterized in that a suction duct (15) for excess powder extends through the fixed member (13) and is adapted with its opening in the closed portion (16) of the tumbler (12), where the extruder (1) is also situated.
9. An apparatus as claimed in any one of the preceding claims, characterized in that the cutting means (29) for the pellets (6) comprises an annular compressed air jet, which is directed towards the centre of the extruder nozzle (3) for intermittently cutting off the pellet strings (5).

AMENDED CLAIMS

[received by the International Bureau on 1 June 1994 (01.06.94);
original claims 1,6 and 7 amended; other claims unchanged (3 pages)]

1. A method of producing plant nutritive strings or pellets from wastewater treatment plants, so-called raw
5 sludge, with a water content normally in the region of 70-80% (30-20%, dry substance, DS), where pelletization takes place without further dewatering of the sludge (2) and where a powder (9) is used to stabilize the strings or pellets (6) and prevent their sticking to-
10 gether, **characterized** in that the powder (9) is added in connection with the sludge (2) being formed into at least one pellet string and after formation of the string is eventually cut into pellets (6), an air stream
(7), in which the powder (9) has become entrained being
15 used to douse the pellet string or the cut-off pellets such as to give the soft pellet string and/or the cut-off pellets (6) improved strength, and to prevent the formation of pellet aggregates during subsequent collection of the string and/or cut-off pellets (6),
20 whereafter drying is readily performed to provide a predetermined moisture content of about 10-15% (90-85%, DS) adequate for storage.

2. A method as claimed in claim 1, where pelletization
25 takes place preferably with the aid of an extruder (1), through which the sludge (2) is urged towards at least one extruder nozzle (3) having at least one extruding orifice (4), and preferably a plurality of such orifices arranged adjacent each other, through which the
30 sludge can be urged such as to form a plurality of separate, mutually parallel pellet strings (5), **characterized** in that after exiting from the orifices (4) said strings (5) are cut into separate pellets (6) simultaneously as the actual strings and/or the pellets

(6) are continuously doused with the air stream (7) and its entrained powder.

3. A method as claimed in claim 1 or 2, characterized
5 in that the powder entrained in the air stream (7), which is directed towards the orifices (4), is a lime powder (9), which first coats the pellet strings protruding from the orifices as well as the cut-off pellets (6) when they are in an air space in front of
10 the nozzle (3) and when they fall down into a depression (10) below the nozzle (3), said depression (10) having room for a powder mass (11).

4. A method as claimed in any one of the preceding
15 claims, characterized in that the pellets (6) coated with excess lime are rotated in excess lime powder, which collects at the bottom of the rotating tumbler (12), said pellets being discharged from the tumbler via a slot (17), while excess powder from the pellets
20 is recovered.

5. A method as claimed in any one of the preceding claims, characterized in that the flow of powder-coated pellets (6) coming from the tumbler (12) via the slot
25 (17) is conveyed to a drying kiln (19), in which the pellets (6) are dried for a given time, such as to obtain a moisture content of about 10-15% (90-85%, DS), subsequent to which the pellets (6) are stored and bagged.

30 6. A method as claimed in claim 5, characterized in that the sludge or pellets are heated during the process in order to kill pathogenic bacteria, parasite eggs etc..

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7. An apparatus for producing plant nutritive strings or pellets from the sludge arising from wastewater treatment plants, and which includes an extruder (1) with a nozzle (3) provided with at least one orifice (4) for forming the sludge (2) into at least one pellet string (5), there also being means (29) for cutting pellets (6) from the string (5), characterized in that there is at least one blowing nozzle (14) for powder (9) in coaction with the orifice (4), said powder being entrained in an air stream, which is directed towards said pellet string (5) and pellets (6) eventually cut off from said string, in that via a fixed member (13) the extruder (1) is surrounded by, and opens out into, a rotatable tumbler (12) having excess powder at its lowest region, and in that via a slot (17) the tumbler (12) opens out above at least one conveyor (18, 19) for conveying the powdered pellets (6) further to a drying kiln, in which the pellets (6) are dried to a predetermined moisture content during a given time, subsequent to which the pellets are ready for storage and bagging.

8. An apparatus as claimed in claim 7, characterized in that a suction duct (15) for excess powder extends through the fixed member (13) and is adapted with its opening in the closed portion (16) of the tumbler (12), where the extruder (1) is also situated.

9. An apparatus as claimed in any one of the preceding claims, characterized in that the cutting means (29) for the pellets (6) comprises an annular compressed air jet, which is directed towards the centre of the extruder nozzle (3) for intermittently cutting off the pellet strings (5).

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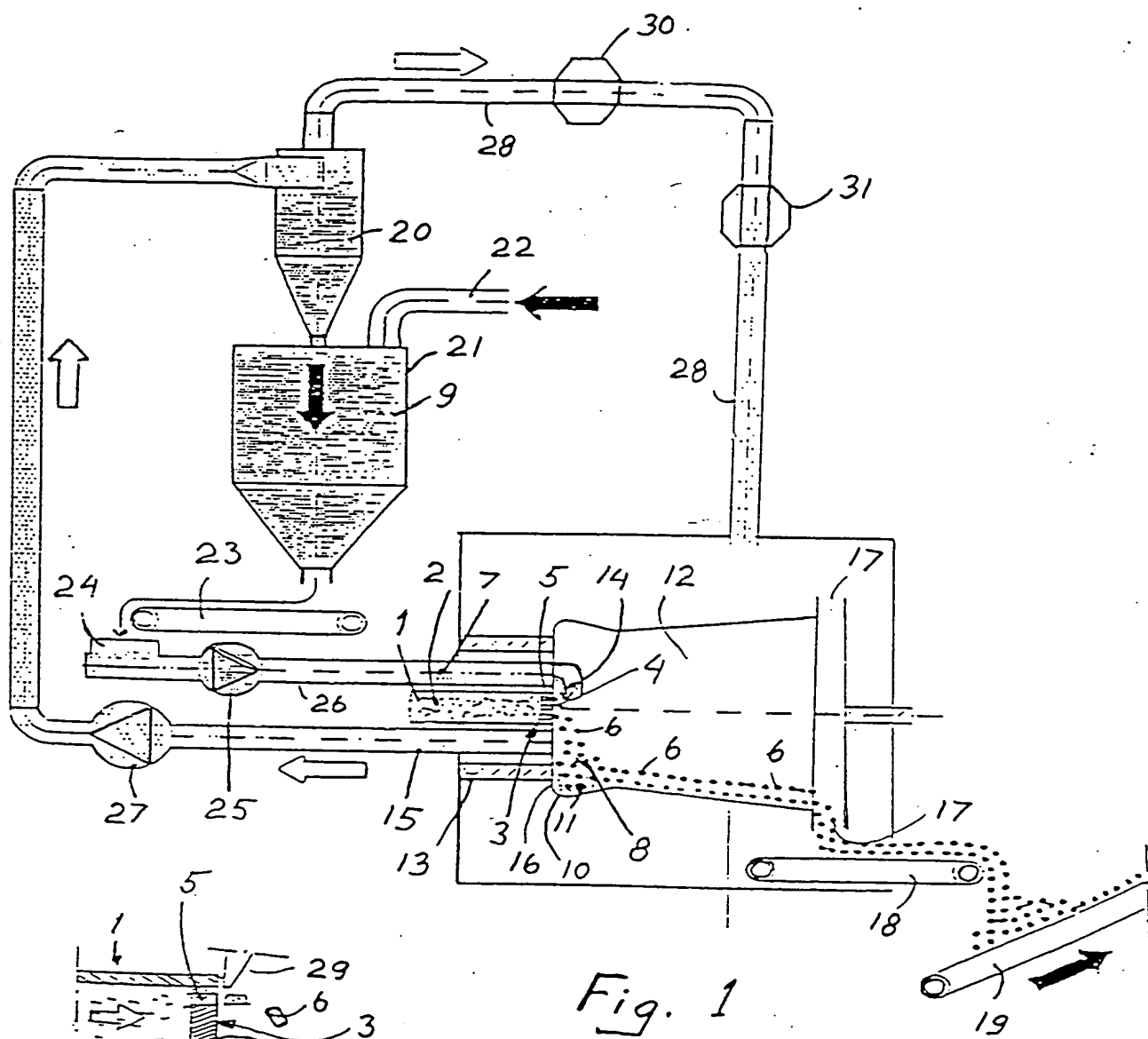


Fig. 1

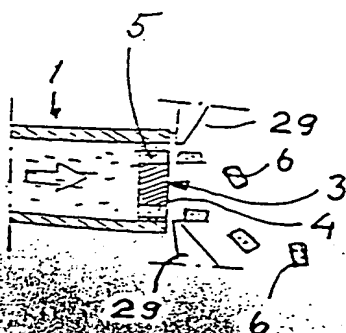


Fig. 2

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: C05F 7/00, B01J 2/20

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B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: CLAIMS, WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, C, 851070 (CHEMISCHE WERKE ALBERT), 2 October 1952 (02.10.52), page 2, line 95 - line 100, claims 1,5 --	1
A	DE, A1, 3540818 (KLÖCKNER-HUMBOLDT-DEUTZ AG), 5 February 1987 (05.02.87), claims 1-3,5 --	1,7
A	DE, B, 1132896 (FARBENFABRIKEN BAYER AKTIENGESSELLSCHAFT), 12 July 1962 (12.07.62), figure 3 --	2

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

30 March 1994

Date of mailing of the international search report

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1
INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 93/01112

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: C05F 7/00, B01J 2/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B01J, C05F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: CLAIMS, WPI

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Date of the actual completion of the international search

Date of mailing of the international search report

30 March 1994

08 -04- 1994.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 93/01112

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>Dialog Information Services, File 351, World Patent Index 81-93, Dialog accession no. 003498936, WPI accession no. 82-46901E/23, KURIHARA K: "Soil improving agent comprises ground, digested sludge adsorbed or coated with dry powder". JP 57070181, A, 820430, 8223 (Basic)</p> <p>--</p>	1
A	<p>EP, A1, 0319789 (LIMUS UMWELTECHNIK GMBH), 14 June 1989 (14.06.89), claims 1,11</p> <p>--</p>	1
A	<p>US, A, 4193206 (VERE MAFFET), 18 March 1980 (18.03.80), figure 1, claim 1</p> <p>--</p> <p>-----</p>	1

INTERNATIONAL SEARCH REPORT
Information on patent family members

26/02/94

International application No.
PCT/SE 93/01112

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			GB-A-	1599568	07/10/81
			JP-A-	53134268	22/11/78
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